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# A User Feedback Ontology for Context-aware Interaction

Nesrine Mezhoudi & Jean Vanderdonckt
Louvain Interaction Laboratory, Louvain School of Management (LSM) – Place des Doyens, 1
Université catholique de Louvain (UCL) – B-1348 Louvain-la-Neuve, Belgium
{nesrine.mezhoudi, jean.vanderdonckt}@uclouvain.be

***Abstract*—**The diversity of interactions flows offers a large amount of information that can contribute significantly the interaction context-awareness at runtime. Particularly, users interventions can indicate accurately user's preferences and needs and can improve the personalization process. User's feedback looks promising to provide knowledge and assessment for an effective adaptation performance. However, there is no any agreed terminology for gathering and assuring the full understanding of what "Feedbacks" represent for adaptation, what is the added value? what it entails and how it could be interpreted.

In this paper, we propose an extensible feedbacks ontology focusing upon the multidimensional nature of feedbacks and addressing the runtime personalization process.

***Keywords—user feedbacks; ontology; adaptation; user-centeredness.***

## I. Introduction

Obviously, interaction evolves with technologies advances, and then the variety and heterogeneity of new contexts of use comes out further interaction scenarios raising novel adaptation challenges. Still, accommodating context requirements and user need a crucial requirement for maintaining the UI usability. Therefore adaptation becomes the key solution for current computational UI settings, of ubiquity, mobility, pervasiveness, responsiveness and context-awareness. However, efficiency and effectiveness of adaptation stills a shortcoming since there is no arranged technique for greatest adaptation. The main purpose of adaptation is to increase the users satisfactions and enhance their experiences during interaction.

Accordingly, system should be smartly reactive and provide a correct reaction for corresponding events; those reactions should be treated with regards to the end-user needs and expectations. Commonly systems recognize the context variations and perform a particular reaction already encoded as an adaptation strategy for the stated context, however we believe that a successful Context-Aware Adaptation (CAA) needs to be more guided by contemplating users feedbacks during interaction. Users opinion on adaptation is a fundamental feature to recognize their satisfaction level. Further it allows to maintain the system usability during adaptation since unexpected UI changes could frustrate users and results the interaction breakdown [12].

The most commonly cited issues with UI adaptations are the lack of predictability, control, and privacy [Findler et al. 08], because adaptation considers prior interaction knowledge. The user often does not have to control to intervene in a context-aware adaptation, however adaptation should capitalize more on their preferences to prevent interaction disruption. Such adaptations are based on taking advantage from users feedbacks during interaction to reinforce adaptation "user-awareness", besides the extraction of additional supplied acquaintance for personalization. Considering users feedbacks and learning users preferences during interaction for adaptations is intended to increase user satisfaction degrees of time. The system variance should show a jump from the adaptive mode to proactive one [16] by considering the perception of feedbacks stimulus and then interpreting it.

Literature conveys several techniques allowing users to intervene, rather than advanced algorithms that have been proven to recognize and resolve knowledge extraction issues and runtime adaptations. However, still the accurateness of feedback perception and its usefulness for producing meaningful adaptation a challenge. In spite of the considerable number of research addressing feedbacks, there is no generalized or common understanding about feedbacks effects and usefulness for adaptation, learning and interaction quality. Accordingly the reuse of works is complicated and the extensibility is complex. We consider feedbacks as an essential feature of interaction flows necessitous for adaptation learning and personalization.

This paper presents an extensive user' s feedbacks ontology modeling user intervention during interaction. This feedbacks model will be used in the Jounum project [22] to solve several key challenges of intelligent personalized recommendation by supporting context-driven adaptation of the interface and the recommendation list in numerical journal.

This paper is structured as follows: A short overview of the user feedbacks requirements to support an intelligent user-centered adaptation is given in section 2. Further, we describe related work on existing user interventions in human computer interaction and their shortcomings. We then present our feedbacks ontology proposal in section 4 and end up with a conclusion and future works in section 5.

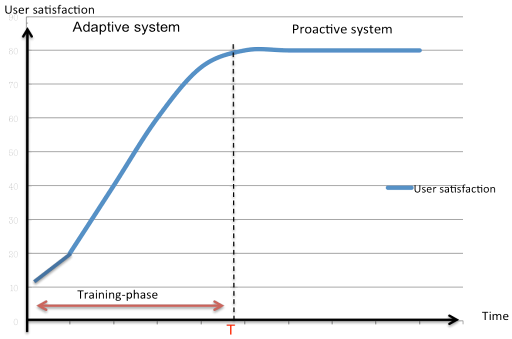


**Figure 1. Estimation of user-satisfaction degrees by time[16]**

## II. Related works

### *A. Feedbacks*

At its most basic levels, user feedback is information provided by users about his preferences and/or goals. It gives information on the accuracy, adequacy, correctness and appropriateness of the system state.

The usefulness of feedbacks depends on several factors such as the nature of feedback stimulus and how it is handled by the system. In order to establish an effective personalization, user preference needs to be learned. However, it is difficult to obtain accurate and sufficient user representation from the user profile and abstract user models. Accruing information about users based on their interaction and feedbacks is promising to improve their satisfaction. Backs to 83, [18] defined feedbacks as "information about the gap between the actual level and the reference level of a system parameter which is utilized to alter the gap in some way".

Numerous studies deal with the end-users interventions in terms of implicit and explicit user feedback; such studies also investigate which data to gather and respective approaches.

As every user interaction can contribute to an unreserved interest-indicator [4], many researches give intention to the unconscious interaction as useful data for adaptation [14], [6], [13]. However, as [7] and [9] remarks, the implicit feedback does not illustrate a dislike-attitude and outcomes a high inherent noise.

As well knowledge can be acquired by asking the user during the interaction in an unambiguous way, which shows generally more expressivity than implicit feedback.

By the same token, [9] recommend the use of satisfactory analysis techniques as the most accurate practice for adaptation decision-making.

The literature offers several techniques to gather explicit/implicit feedback [1, 4, 7, 9]. Both explicit and implicit feedbacks provide different degrees of accuracy and expressivity besides varying degrees of investment and commitment to deliver the expected benefits. [9] compared both implicit and explicit feedbacks in term of accuracy, abundance, context-sensitivity, expressivity and measurement references through a music recommendation systems. Results are presented in the table 1.

Tableau 1 **Characteristics of explicit and implicit feedback [9]**

| | Implicit feedback | Explicit feedback |
|---|---|---|
| Accuracy | Low | High |
| Abundance | High | Low |
| Context-sensitive | Yes | Yes |
| Expressivity of user preference | Positive | Positive and Negative |
| Measurement reference | Relative | Absolute |

### *B. Requirement for Users Interventions*

Still, user preferences are the most relevant constraint to define adaptation that improves UI usability [2, 16]. Involving users is typically needed in order to verify and/or rectify the result of UI adaptation and endorse system decisions [10]. An advanced adaptation has to consider pre-existing knowledge besides novel acquired data about users experience with the system. Such experience summarizes users preferences and needs, which should to move the adaptation engine by means of his interventions and feedbacks. Not only the users should be able to accept, reject, asses or change adaptation rules, but also the system must be able to learn from their intervention for adjusting decisions, improving its performance and accuracy.

The need for involving user was largely revealed by HCI communities [17, 5, 10, 11]. Damodaran (1996) presented a list of five benefits that user involvement has shown in several studies: (1) improved quality of the system arising from more accurate user requirements; (2) avoidance of costly system features that the user did not want or cannot use; (3) improved levels of acceptance of the system;(4) greater under- standing of the system by the user resulting in more effective use; and (5) increased participation in decision-making within the organization. In [17, 11], authors distinguish three benefits for involving end-user for participatory design: democracy; efficiency and commitment [10, 11, 17].

In summary, it is commonly agreed that user involvement allows a better understanding of the context circumstances and user preferences consequently gathering and interpreting feedbacks information enhance the user satisfaction and system usability.

## III. User feedbacks in UI adaptation

This section incomes a user's perspective on context-aware personalization by focusing on user's motivation and perception within dynamic surroundings context and changing preferences. Further it aims to demonstrate the role and importance of user involvement for estimating context-aware adaptation.

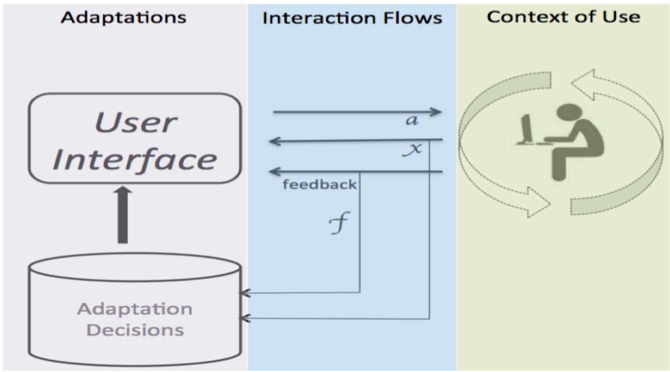


**Figure2. Model of intelligent adaptation based on user's Feedbacks**

Previous research identified a clear need for more flexible user control and involvement for the improvement of interactions and the support of learning [15]. An additional confirmation of the impact of user involvement comes from the guidance for adaptive and intelligent systems[12, 16].

User involvement refers to the degree to which the user is involved in the accomplishment of interaction tasks. HCI's "feedback loop" (figure2), for personalizing systems provides a significant test bench for discovering the principles behind an intelligent context-aware user-centered adaptation. End users are allowed to judge their system's performances. On the other hand, systems are endorsed with the capability to process those information's and interprets them. This structure provides an opportunity to increase the usefulness of feedbacks.

At the highest level, three independent fundamental features are involved during interaction loop.

- Users within their changing context of use, which influences their perception and their accomplishment of an interactive task [3]. Three items to define the context of use: the user who performs the tasks, the platform to support the interface and the environment that surrounds the task achievement [3]. Adaptation should accommodate contextual changes, while respecting user need and expectations rather having a crosscutting impact on UI in harmony with the situation and the ambient-context.

- Adaptations: concerns: (1) deciding on the need for adaptations based on some assessment of the context and interaction; (2) performing adaptations through a certain strategy and processes.

Furthermore, this pack is aimed for analyzing contextual facts. Gathered context data and users intervention are intended to serve in regulating system performance, when it provides assessment about adaptation outcomes.

The adaptation repository allow a training phase of adaptation through the following accomplishments; (1) Executing pre-existed adaptations extracted from guidelines and patters, which serve by way of a training set to (2) detect a model of user behavior throughout his interaction and feedbacks. Besides, (3) coming up with improved performance showing the usefulness of gathered data. The adaptation management is achieved through the information exchange among system constituents and between the system and its environment.

- Interaction flows: describes the exchanged information's flow between the user and the system. It is defined as an interaction loop. The interaction needs to follow certain templates, scenario, and protocols. The main advantages for identifying interaction are to:

- Engage the user through their feedbacks to assess the performance of system.

- Obtain a preliminary understanding of the gap between system decision and expectation through the user behavior and by linking user' knowledge and intuition.

- Build evaluative models for the adaptation processing and system performance.

Earlier, Considered "feedback information" has been emphasized by systems for guiding the user in their interaction, such feedback provides guidance for user to accomplish their tasks. User guidance refers to error messages, alarms, reminders, and labels, as well as to more formal instructional material provided to help a user during interaction.

However, recent UIs assume that "Interfaces must adapt themself to the users and simplifies their tasks, not the reverse". Accordingly, guidance is no more effective for maintaining usability and interface shift toward acquiring guidance from users to improve their performance.

Several potential feedback's practices are defined with different aims such; Evaluative for instance "emoticons based feedback" aiming at expressing the satisfaction degrees among end-user via picking an emoticon judging his user experience [16], Comparative, such as recommendation frames that offer a simple interaction illustrated differently (e.g. pop-up window, Sliding area), which is mainly used to provide client recommendations. Likewise, they may allow end users to express their preference by accepting or cancelling the system recommendation.

## IV. USER FEEDBACKS ONTOLOGIE

As discussed above, user's feedbacks is promoting for interaction enhancement. However the usefulness of the feedbacks information depends upon their: (1) consistency which refers to the extent to which the feedbacks communicate a positive or negative judgment, and (2) credibility and accuracy concerned with how accurately the recipient perceives the feedback from source [8].

Both implicit and explicit feedbacks exhibit different points of users' preferences with pros and cons. Assuming that Users' needs constantly change, developers reinforce users involvement by enabling more users participation through feedbacks in order to enhance visualizations, (1) to offer more explanatory facilities, provide better setting of user expectations, (2) to specify deeper understanding of the context of use, and (4) other improvements that considerably upgrade usability.

The combination of these two types of feedback (implicit/explicit) provides another paradigm for adaptation. Their combination in a user preference model presents a number of challenges and enhance the performance and accuracy of adaptation decisions [19].

The feedback allows evaluating the adaptation decisions taken rather than instructing upcoming adaptation by providing correct guidance. This is what creates the need for active exploration of users reactions through their explicit opinions, implicit one and behavior. Numerous works investigate gathering subjective user feedback for effectiveness and satisfaction [5, 8 ,18]. Different techniques were identified with a common purpose of supporting the improvement of the interaction quality and the appropriateness for the end-user preferences.

In order to provide a common understanding of the structure, credibility and information value of feedbacks among stakeholders we outline a user feedbacks ontology enabling a formal feedback's analysis. We believe that such ontology could provide stockholders an unambiguous specification of feedbacks improving its consistency and usefulness. Ontologies provide classes of objects, relationships and domain constraints on their properties. By drawing feedbacks concepts within an extensive ontology, structured information can be shared. We define three main classes to establish our ontology, the role, the significance and the modality (figure 3).

The Role's outline the feedbacks as an incentive. Feedbacks acts as an incentive when it conveys a reward that affects system behavior and performance. Recognizing that feedback allows a user's subjective assessment of the gap between current and intended system performance, it's incentive character could be achieved through four dimensions; of evaluating, valuing, organizing and correcting.

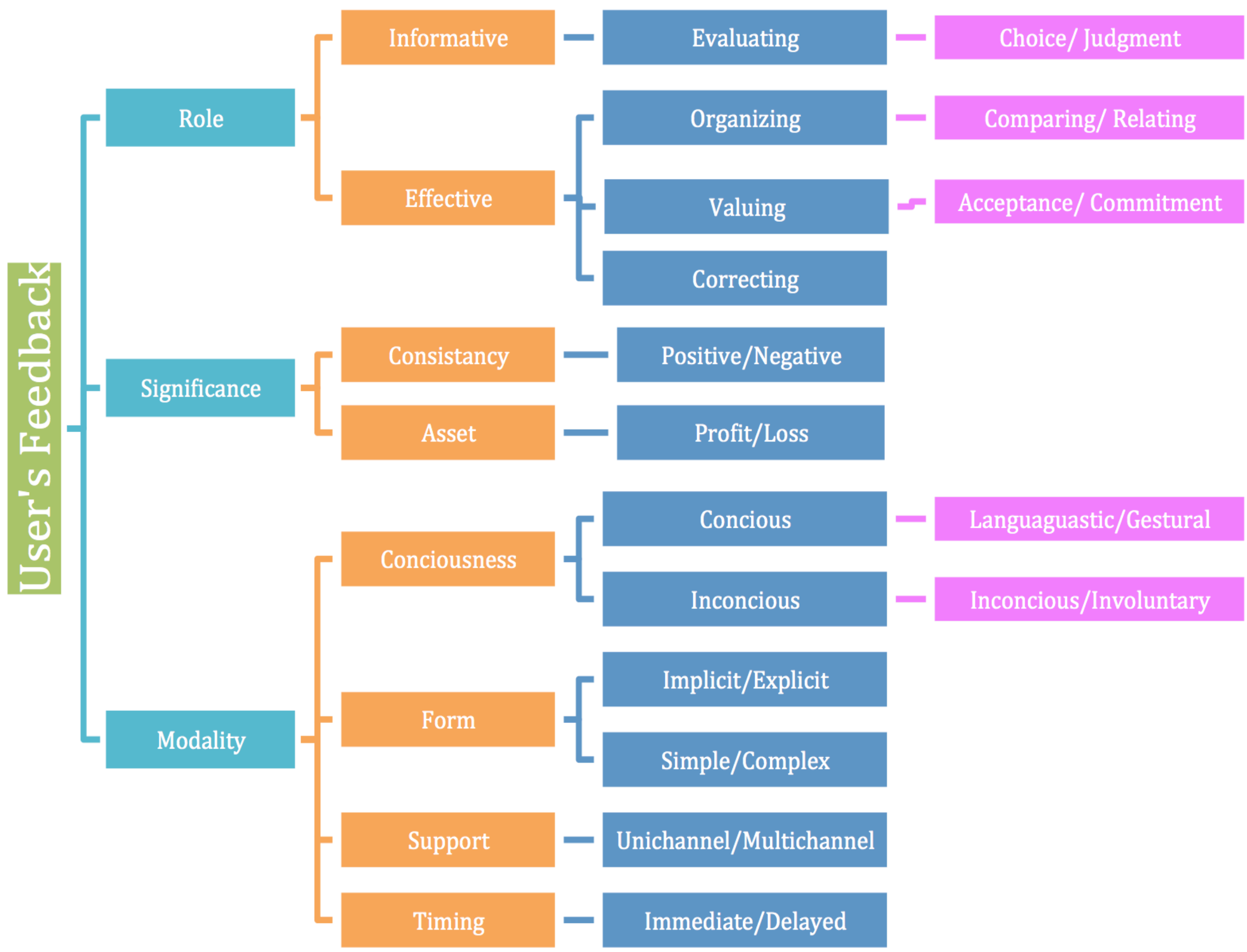


**Figure3. A user's Feedbacks Ontology**

Each dimension provides the user with the ability to relate to his personal preferences within an informative or effective manner.

• Evaluating. In this case, feedbacks represent a point along a continuum of goodness/badness scale. Systems are provided a transparent evaluation of their performances with respect to the goal. Evaluative feedbacks are meaningful in the purpose of usability assessment, and establish a basis to upgrade it. It takes a variety of evaluation forms; choice when the user explicitly promotes a solution, judgment in the case of ranking explicitly an interface feature. For instance “emoticons based feedback” aiming at expressing the satisfaction degrees among end-user, via picking an emoticon judging his user experience. Arhippainen [1] give an instance application of an answering to feedback problem with emoticons.

• Valuing. It refers to the extent to which the feedback’s valuing of information indicates goal accomplishment and performance concerns. Feedbacks could serve as a (reward and/or punishment) allowing to promote/demote system performances (more technically, as a secondary rein- forcer), if, over time, the combination of feedback from certain positive and/or negative outcomes leads to carry on reinforcing properties. Knowing that the usefulness of valuing feedbacks depend on the system ability to engage in an efficient dialog with the user. Respecting the fact that systems should be endowed with the ability to infer such feedback and continue to learn about a user’s goals and needs.

• Organizing. Feedback serves a purpose in organiza- tion; it may be stabilization, control, growth, or change. To attend every purpose, a mindful assessment has to be made for the gap between the actual status and the expected value of a parameter, invoking or not invoking, making choice, and ordering services. The value of feedback providing new knowledge can be improved by providing efficient means by which users can directly invoke or promote the features. Likewise, they may allow end users to show their preference by accepting or cancelling the system recommendation.

Significance. This perspective denotes the focus and accuracy of feedbacks independently of the effects. It concern the role of the feedback in putting forward a set of indicators required from users in order to determine the appropriate correlations between a particular behavior and a satisfaction level.

• Consistency: Positive / Negative. This dimension relates to the reliability of feedback. Mainly the extent to which feedback may be positive or negative. Positive feedback means a very good and satisfactory response of the user. Negative feedback means an indifferent response to the feature or a flawless dissatisfaction. Correspondently, from the system side positive feedback could perceive and recalled more accurately than is negative feedback when they are not explicitly conveyed.

• Asset: Profits / Losses. Feedback can improve the profits of an application or the opposite. If a user reacts positively, it changes its marketing strategy and achieves progress. A negative feedback (silence, forged feedbacks) may be responsible for the weak and lop sided business. This dimension takes into account the engagement of users in the communication and the credibility of their feedbacks for systems.

Modality. Characterize the form of a user inputs data. The variety and complexity of existing methods for eliciting feedback result confusing communication flow. In order to handle such complexity we proceed to analyze feedbacks stimulus regarding four dimensions.

• Consciousness: Conscious/Unconscious. It represents if the feedbacks performer has a specific goal. When goals are general and feedbacks are unconscious the system may have some difficulty in relating users preferences. According to [8] the more specific the feedback, the more information is provided for being able to set specific goals (see figure4).

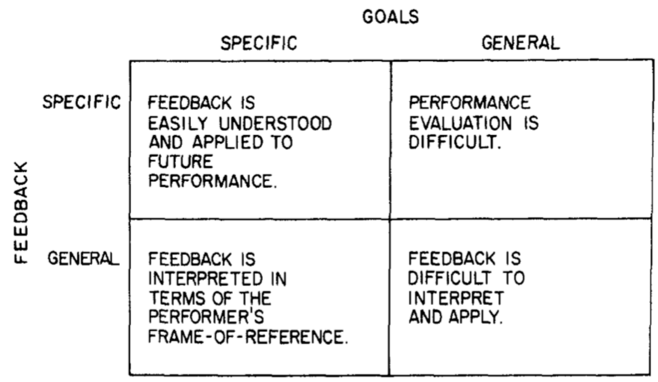


Figure4. Interaction of goal and feedback specificity [8].

• Form: Implicit/explicit. It is interested in how accurately the feedbacks could be expressed and perceived. Diverse degrees of expressivity are provided depending on feedbacks format. Generally explicit feedbacks is perceived and recalled more accurately than implicit feedbacks. In standard explicit feedback, the user will provide ratings for items. Thus explicit feedback captures both positive and negative user preferences. On the other hand, implicit feedback can be positive. For example, if a user did not listen to a track that does not mean he does not like the track.

• Simple/Complex. Feedback can be simply through a nod of the head, conveying a brief yes or no, or it can be complex as a lengthy written response.

Feedback involves circling back of information to a control method to adjust behavior. For instance users could express their satisfaction levels via simple widget, or by adjusting the system sitting, and in same case the feedbacks could be a reporter.

• Support: Unichannel/Multichannel. This dimension provides an opportunity to define the feedbacks communication channel. Fisher [21] identifies two main communication channels for UI interaction. The narrow explicit communication channel and the implicit communication channel. The implicit channel requires a considerable amount of knowledge about problem domains, communication processes, and the agents involved [21] (figure

5). A feedback stimulus could be provided through a different channel. In the typical case, diverse elements included under the single rubric of feedback could share the role of conveying information about past system behavior or performance assessment which increases the feedbacks accuracy. However, the complexity of a multichannel feedback could be confusing rather than meaningful.

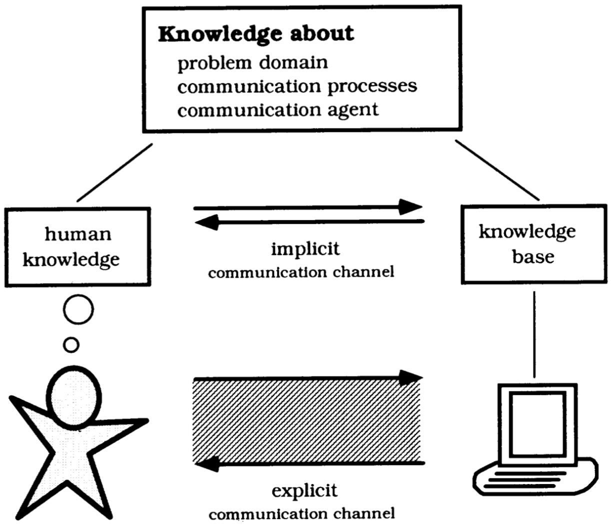


Figure 5. Knowledge based Human computer Interaction [20].

Timing: Immediate/delayed. The timing dimension refers to the interval between the user feedbacks and the system reaction. When the feedback and system reaction are not consecutive may affect the learning process. According to [8] UI response tendencies weaken over time, accordingly delayed negative feedback is affected by less proactive interference. On the other hand, positive feedback is not affected by the interference when given immediately after the response or later, so the delay is less of an issue [8].

## V. PERSPECTIVES AND HEURESTIQUES

In the typical case, defining the appropriate feedback depends on several aspects:

"Know the user" is the first interaction principal. It is commonly assumed that the process of knowing the user is never ending, because users keep changing. However, a generic separation into novice, knowledgeable and expert users might lead to different interaction design and permitted feedbacks. User profile provide an indication of the asset, consciousness and consistency of feedbacks.

The task profile: besides users and their preferences, the tasks must be identified in term of complexity, functionality, accessibility, frequency etc. We assume that designing interaction and defining the user feedback with regard to the task's controllability improve the interaction.

Furthermore, the environment and the platform of interaction contribute to the definition of the interaction style. The situation context influences the feedback in term of quality, support, form etc. Contextual information has proven useful for aiding the interpretation and recognition of diffrent ffedbacks such as speech recognition, visual feedbacks recognition [22,23].

Some heuristic based on the experience are presented in what follows:

H1: Expertise/Trust trade-off. For every system adaptation action, there should be some user feedbacks. For regular action the user offers a useful guidance. However task performance and low error rates occur only if some condition are assured such as, Users knowledge's are adequate for the problem solving tasks, and the system feedback is produced about the progress of change etc. The level of engagement reflects the extent to which the public can influence the decision-making process.

H2: Syntactic-semantic model. Direct manipulation of the system improves interaction. Allowing the user to act on their object of interest reduce the system complexity. According to [20], task semantics dominate the users' concerns and the distraction of dealing with the computer semantics and the syntax is reduced. For instance allowing the user to make feedbacks while dealing with the representation of an object allows more natural interaction.

H3: specificity-generality. Feedback is important for learning user preferences. The principle consists on simplifying user tasks, eliminating human action when no judgment is required.

H4: Time is precious. Delays when responding to feedback become frustrating. Change is seen as unexpected, even if user initiated it because of the length of response time. On the other hand reacting quickly is danger in case of ill-considered decisions. The outcome could be catastrophic for instance in air traffic.

These informal conjecture need to be qualified and verified. s well a more rigorous feedbacks specification has to be performed to accommodate the diversity of users, task, and context.

## VI. CONCLUSION AND FUTUR WORKS

The necessity of ontologies for the specification of context and the establishment of context-aware systems is broadly acknowledged. On the other hand, the improvement made by considering-end users feedbacks reveals their great efficiency in maintaining UI usability and enhancing user satisfaction.

In this paper, we presented a basic, generic ontology for the description of feedbacks information. The ontology consists on four main dimensions for feedbacks characterization: the role, the significance and the modality.

The ontology enabled us to extract fundamental concepts of users feedbacks. Based on the gained experience on user interventions through the Jounum project the ontology will be further refined. As well the consideration of user intervention for the UI adaptation and the personalization of recommendation will capitalize on a unified, exhaustive study of feedbacks. This analysis is intended to enhance the accuracy of information value provided by the feedbacks stimulus.

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